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Free choice, waiting time and length of stay in Norwegian hospitals

by

Egil Kjerstad
Frode Kristiansen

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Free choice, waiting time and length of stay in Norwegian hospitals

Egil Kjerstad[1], Institute for Research in Economics and Business Administration and Programme for Health Economics in Bergen

and

Frode Kristiansen, Institute for Research in Economics and Business Administration

Abstract

In many countries' public health care systems patients now have choice of hospital. Hospitals compete by offering quality services. In Norway, freedom of choice was expected to reduce waiting time for planned admissions. Using a data set of approximately 56,000 patients classified in fourteen different Diagnosis Related Groups (DRG) over the four year period 1999-2002, we find that migrating patients wait on average two months less for treatment compared to patients choosing the hospital closest to their home municipality. We also find that migrating patients stay approximately one day shorter in hospital compared to non-migrating patients.

JEL Classification Code: I18, D45, C31

Keywords: free choice, waiting time, length of stay

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[1] Corresponding author: Egil Kjerstad, Institute for Research in Economics and Business Administration (SNF), Breiviksveien 40, N-5045 Bergen, Norway; e-mail address: egil.kjerstad@snf.no.

1 Introduction

The utilization of many social services is rationed by waiting lists[2] rather than prices. The causal relationship between waiting lists and resources allocated to social systems characterized by long waiting lists is of concern for users, staff and politicians alike. Martin and Smith (1999) find – in a study of the National Health Services (NHS) in the United Kingdom – low elasticity of demand with respect to waiting time, suggesting that increased resources may reduce waiting times without greatly stimulating utilization. Martin and Smith (1999) develop a framework that takes both demand and supply sides into account. Others, like Pope (1992) and Roland and Morris (1988) argue that increased funding would have little impact on waiting times. More resources would simply induce greater demand.

Another strand of literature evaluates the effect on waiting times of institutional changes in the way health services are organized and funded. Hamilton and Bramley-Harker (1999) find that waiting time for emergency hip fracture surgery declined after the internal market reforms of the NHS in 1991.

A third strand of literature evaluates the effect on waiting times of allowing patients to choose more or less freely among different providers. In many countries, Governments have removed limitations placed on patients' choice of hospital and opted for a free choice policy.[3] One of the main arguments in favour of such a policy is that free choice will help to drive service improvements transforming health systems into more responsive, patient-centred services. The argument may have some merits. Given that most health care systems are price regulated,

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[2] Using waiting lists as a rationing device imposes no cost in form of wasted time as opposed to rationing through waiting lines in which the demander of the service must be present waiting for his/her turn. Market clearance in the case of waiting lists is brought about by the fact that the utility derived from the consumption of the good declines the longer the individual has to wait for the good (Lindsay and Feigenbaum, 1984).

[3] See http://europa.eu.int/comm/employment_social/missoc2001/missoc_54_en.htm for an overview among EU member states and the EEA. Spain is now one of the few countries in which free choice has not been introduced. In the USA, managed care health insurance plans often restrict the set of hospitals and physicians from which enrolees may obtain care. HMOs are particularly reliant on these types of restrictions. See Gaynor and Haas-Wilson (1999) for an illuminating discussion of the severe limitations managed care plans in the USA put on the set of hospitals and physicians from which an enrolee may choose.

the free choice policy basically means that hospitals compete along dimensions of quality.[4] Waiting time is an important quality dimension of any national health system. Another argument in favour of free choice is that increased patient mobility will better align supply and demand: Spare capacity at one hospital can be matched by surplus of demand elsewhere. In short, the resources envisaged necessary to reduce waiting times, given local monopolistic hospital markets, may not be the same as resources necessary to reduce waiting times allowing for competition on a national level. To facilitate the latter, allowing free choice of hospital should stimulate patient mobility. Propper, et al. (2002) – in a study of the UK general practitioners' fundholding scheme – find that patients of fundholding practices had shorter waiting times compared to patients belonging to non-fundholding practices. Dusheiko et al. (2004) reconfirm these results using a national data set and a broader set of analysis. Yeung et al. (2004) study 'doctor shopping' in a mixed medical economy, i.e. a system in which patients can seek private sector care as an alternative to the public health care. Using data from Hong Kong, they find a positive association between patients' expressed value of time and 'doctor shopping'. Patients who were assigned longer waiting times relative to their expected waiting time horizon in the public health system were more likely to seek private alternative care.

This paper is a study of the impact of free choice or increased patient mobility on waiting times and lengths of stay in a public health system comparing both public hospitals and private hospitals under contract with the public health care system. We do not study the effect of increased patient mobility on the number of patients on a waiting list at a given time but focus on the effect on waiting time and length of stay for patients that receive treatment. We define waiting time as the time that elapses between referral and admission to hospital, and length of stay as the time between admission and discharge. Using a data sample that consists

[4] Governments may have to facilitate such competition by making quality differences transparent to patients.

of approximately 56,000 inpatient records from Norwegian hospitals - patients are grouped into 14 different Diagnosis Related Groups (DRGs) – over the four year period 1999 – 2002, in combination with travel (distance) data and data on the patients' home municipality, we address three questions:

Q1: Do migrating patients have different characteristics compared to non-migrating patients?

Q2: Do migrating patients experience shorter waiting times compared to patients treated at their nearest hospital?

Q3: Do migrants experience shorter length of stay compared to patients choosing treatment at their nearest hospital?

We find that a number of background characteristics significantly increase the probability of migrating. Not the least, we find that migrating patients experience shorter average waiting times compared to non-migrating patients and that migrating patients have a significantly shorter length of stay compared to non-migrating patients.

The rest of the paper is organized as follows: In Section 2 we describe the free choice policy in Norway. Section 3 presents data and gives some preliminary evidence of the effect on waiting time and length of stay for migrating vs. non-migrating patients. In Section 4, the econometric framework is discussed with emphasis on the endogeneity issues attached to self-selection and the possible causal relationship between waiting time and length of stay. The results of the study are presented in Section 5, while a discussion of the results along a few main themes follows in Section 6. Concluding remarks are gathered in Section 7.

2 A brief outline of the free choice policy in Norway

A long lasting quality deficit in the Norwegian health care sector has been the relatively long waiting time for certain treatments at outpatient clinics and for inpatient care.[5] Over the years, politicians, hospitals and patients' interest groups have demanded more resources to the hospital sector using long waiting time as one of the main arguments. It is fair to say that lobby groups have succeeded in the sense that the hospital sector has been faced with soft budget constraints for a number of years. The argument that hospital care is free of charge and that the demand then has to be rationed by queues, has never been seriously used as a counterargument by the Ministry of Health. The Ministry has, rather, criticized hospitals for under-performing in terms of cost efficiency. However, soft budget constraints have the potential to accentuate cost inefficiency problems.

In 1997, the payment system for inpatients was changed from a pure block grant system to a DRG based prospective payment system, introducing fixed per patient remuneration in combination with block grants. The main argument in favour of introducing a DRG based prospective financing system was to improve the match between resources and demand to reduce the number of patients on waiting lists.[6] This was the same main argument in favour of implementing a free choice policy in January 2001.

The free choice of hospital service is web-based, giving information about waiting times for a number of treatments across most hospitals in the country. The goal of the service is to make other quality indicators, such as the number of hospital infections and death rates, transparent as well, but there is still work to be done in that regard. Waiting time data is still the most coherent service quality information available. The service does not demand that the patient

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[5] Hurst and Siciliani (2003) reviews policy initiatives to reduce waiting times in twelve OECD countries and Siciliani and Hurst (2003) investigate the causes of variation in waiting times for non-emergency surgery across countries.

[6] Kjerstad (2003) finds that the reform had a positive effect on the number of patients treated but the study does not focus on the effect on waiting times.

her/himself has access to the web. The normal method of access to the free choice service is through the patient's doctor. Each person in Norway has chosen or been allocated a general medical practitioner. For many patients, information on waiting times is most likely found in co-operation with his/her GP. In any case, it is the GP that makes the referral to the chosen hospital. Finally, it is worth mentioning that the waiting times posted should be regarded as expected waiting times not necessarily the waiting time experienced by a particular patient.

Free choice of hospital was included in Norway's Patients' Rights Act (PRA) introduced in January 2001, together with the right to assessment of illnesses; to a second opinion; to treatment; to involvement and information; to health care; to access medical journal content; special rights for children and so-called patient representative agreements. Thus, free choice was implemented at the same time as a whole package of patients' rights.[7]

Although the free choice possibilities are at national level, health regions remain administratively separate areas and it is the regional health authorities[8] (RHA) to which the patient administratively belongs that pay for the treatment as a DRG based remuneration. The patient only pays a nominal travelling fee of NOK 220 (approximately USD 35) each way regardless of distance. Up until mid-2004, the social security system covered patients' other travelling expenses. From mid-2004, the RHAs also have to pay these travelling expenses. Thus, the regional authorities may have incentives to minimize the 'export' of patients and maximize 'import'. The way to do this is to reduce waiting times and increase performance along other quality dimensions that also are transparent to patients and GPs. Competition between hospitals may become stronger, particularly in cases where there is excess supply.

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[7] Vrangbæk and Östergren (2004) and Byrkjeflot and Neby (2004) discuss choice in Scandinavian hospital systems and give a comparison of Nordic health care reforms, respectively.
[8] The five RHAs were formally established in January 2002 when the state Ministry of Health acquired the hospitals from the counties.

It is known from the literature on DRG-based prospective payment systems that hospitals with excess demand may 'cream-skim' patients, i.e. choose to treat patients with an expected treatment cost equal or below the DRG remuneration. The situation here is that hospitals signal excess supply, a situation that probably mutes the incentives to 'cream-skim'. Furthermore, 'cream-skimming' is at odds with the stated aim of the PRA, of which the free choice policy is a part. In the PRA, it is stated that need for treatment should be decisive when setting priorities among patients. And, formally, given that hospitals first have signalled spare capacity and an expected waiting time, they have only the possibility of turning down or prolonging waiting time for potential migrating patients if patients belonging to the same health region as the hospital are waiting for the same treatment. In this paper, we are concerned with how best to measure the effect of migrating on waiting time and length of stay, abstracting from possible 'cream-skimming' effects.

Hospitals with spare capacity, and faced with per patients remuneration that exceeds or equals expected treatment cost, will have an incentive to attract patients from previously unavailable catchments areas. On the other hand, patients have incentives to choose a different hospital than their nearest if that can reduce waiting time. Given that patients are weighing travelling time costs against waiting time costs, a free choice policy may lead to shorter average waiting time for migrating patients compared to non-migrating patients. This does not imply that waiting times necessarily decline over time.

Aggregate travelling costs will inevitably increase and so will other monetary and non-monetary transaction costs[9] following a free choice policy. The increase in aggregate travelling cost and other transaction costs are not our focus here, although they should be

[9] Search cost for patient and GP; psychological switching costs for patients; new administrative routines for handling migrating patients at regional level and hospital level.

important components in an overall cost-benefit assessment of the success or failure of the free choice policy.

An additional issue is that a migrating patient, possibly depending on how far away from home the patient is treated, may not be as quickly transferable home or to a institution like a nursing home compared to a patient treated at her nearest hospital. As a result, treatment cost may increase due to longer length of stay for migrating patients. On the other hand, if migrating patients in general are fitter than non-migrating patients, they may be discharged earlier than non-migrating patients with the same diagnosis. These issues are discussed in later sections of the paper.

3 Data and preliminary evidence

The data set for the analysis was established by combining three basic data sets: Foremost is *Hospital stays data* for Norwegian inpatients for 1999, 2000, 2001 and 2002 pooled. These data consist of hospital discharges, comprising the complete set of individual level records. The second data set is *Hospital data,* for all Norwegian hospitals in the national reimbursement system. The hospital data set is mainly a representation of catchment areas and hierarchical structure between hospitals as at 2002. Most Norwegian hospitals are state owned but are organized as parts of local health authorities (LHA) on the local level and regional health authorities (RHA) on the regional level. A few but important private sector hospitals are included as well, grouped into a separate RHA for analysing purposes. The third data set is a *Matrix of distances* between all Norwegian municipalities, measured in driving distance by car in kilometres. Merging of the different datasets was feasible through the values of home municipality of treated patients and location municipality of treating hospitals.

A central objective of the data set merging was to identify *mobile patients*. We define a mobile or migrating patient as a patient treated at a hospital other than the hospital closest to the patient's home municipality. By utilizing the home municipality value of patients, the location municipality value of hospitals and the matrix of distance, several travel distances of interest can be calculated, for example, distances between: a) Patient's home municipality and closest hospital, b) Patient's home municipality and actual used hospital and c) Patient's home municipality and next nearest hospital.

Only elective hospital stays of in-patients are selected for analysis. We focus on planned admissions because free choice of provider does not encompass emergency cases. Both surgical and medical DRGs are included in the sample. In order to obtain a cleaner representation of patient flow between regions (and sectors), we chose to exclude admissions to national level state run hospitals (and their subsidiaries). These hospitals treat patients from all Norwegian RHAs but are organized as parts of single RHAs. Patients within 8 DRGs identified as national level specialities (e.g. heart transplants) and DRGs that normally are excluded from regional or patient mobility analyses (births, dialysis, chemo-therapy and rehabilitation) are also left out. When "day care only" in-patients also are excluded, about 725,000 stays remain as candidates for further analysis.

Based on the DRG codes of the 725,000 stays, a mobile or migrating patient is identified in two steps. First, as a point of departure for identification of mobile patients, the closest hospital for each municipality is identified as the institution where the majority of the emergencies for patients living in the municipality were admitted. Second, when specific treatments are considered the hospital identified as the closest to the patient's home municipality depends on the range of services supplied. The patient's DRG must be in the portfolio of DRGs of the patient's local hospital or at a hospital elsewhere in the patient's home region.

Based on the attribution of closest hospitals, calculated distances and catchment area relations between patients' home municipality and hospitals, all the relevant hospital stays can be classified into three categories:

1. *Non-migrating patients*: Patients treated within the closest LHA that supplies the patient relevant DRG. About 75% of planned admissions fall into this category.

2. Intra regional mobile patients: Patients treated in an LHA other than their closest local unit, but within own RHA, given that the DRG in question is supplied in both LHAs. Patients in this category amount to 18% of planned admissions.

3. Inter regional mobile patients: Patients travelling between RHAs and being treated at an RHA other than their regional unit, given that the DRG in question is supplied in both RHAs. Only about 7% of planned admissions are identified as inter regional. However, the proportion as well as the numbers of inter regional mobile patients are increasing year by year.

In order to focus on the differences between the opposite categories of hospitals stays, all stays at the intermediate level, i.e. within their RHAs, are excluded from the analysis. The exclusion is also motivated by the fact that hospital stays within RHA but in other than the closest LHA, may be a consequence of established regional division of labour. By excluding intra regional mobility, we expect that the reliability of classifying hospital stays as mobile or non-mobile stays will be higher. However, crossing RHA-boundaries does not necessarily imply long travel distances on the patients' part. For a large number of patients, the regional boundaries are institutional more than geographical. In Norway, the main growth in the flow of patients between RHAs, consisting of patients living in the catchment areas of state owned RHAs in central, more densely populated parts of the country, has been to privately owned hospitals.

Some patient characteristics are obvious choices as exogenous variables in analysis (e.g.: Age, gender or even characteristics related to home municipality) but the main factors separating and uniting patients - at least in terms of waiting time and length of stay (LOS) - are related to the diagnosis and treatment that patients receive during their hospital stay. DRGs define patients with common characteristics in terms of both diseases and hospital use of resources. Still, as DRGs are more general than the patient's specific diagnosis, there also will be variations in treatment complexity and required hospital competence within DRGs. Any analysis not taking at least the DRG of hospital stays into account is liable to suffer from noise that will distort the measures of effects of other variables such as age and gender. Performing separate analyses by DRG is one option. Introducing dummy variables per DRG is another and is the approach taken here. It was necessary to explore the complete data set for a manageable subset of DRGs to be analysed together in the same models, controlling for DRG variation by dummy variables. Several selection criteria are applied. First, the selected DRGs must have both a substantial volume of stays and a minimum proportion of inter regional mobile patients. Second, if the flow of mobile patients is limited to only one 'receiving' hospital the DRG is excluded. In sum, our strategy is to include 'big ticket' DRGs that reflect diversity of patients and hospital characteristics.

The DRGs that are included in the analysis are 14 DRGs with a gross of 200 or more patients migrating between RHAs over the years 1999, 2000, 2001 and 2002. Of the total number of hospital stays classified in these 14 DRGs, 16.5% of stays are excluded because of missing waiting time values[10].

The problems associated with reliability of waiting time registrations were also evident

[10] T-tests indicate that excluded stays differed significantly from stays with valid waiting times, in mean values of variables such as AGE and LOS. However, the magnitude of the differences is low, and is considered to not represent a data bias problem.

among the valid observations. Extreme waiting time values outliers were identified by the STATA procedure DFITS that combines the size of squared residuals and their leverage. The exclusion of 4.4% outlier observations was executed with no discrimination as far as the patients' migrating status was concerned. We also excluded all hospital stays with LOS over 60 days. These cases represented less than 0.1% of stays. LOS values for in-patients classified as 24 hours care patients, were converted to minimum 1 day, resulting in conversion of 2.5% of cases across DRGs. After reductions for missing values and outliers the DRG based sample consists of 55,751 hospital stays.

In Table 1, descriptive statistics for the sample data set are presented separately for mobile and non-migrating patients. We list the minimum, maximum, mean and standard deviation values for all DRGs and years for all variables. The number of hospital stays, and the relative fraction of mobile patients varies between DRGs. Thus the different DRGs (and their corresponding traits) have different weight in Table 1, and the totals may be misleading compared to a listing by single DRGs[11]. In total 69.4% of all stays in the sample take place in the patient's closest hospital, while 30.6% of stays in the selected DRGs are identified as inter regional mobility stays. The number of stays and proportion of patient mobility by DRG are listed in Table 2.

(Table 1 around here)

According to Table 1 the proportion of male patients (GENDER) is higher (69%) among mobile patients, than among patients being treated at their closest public hospital (50%). In addition, the mean age of approximately 61 years for mobile patients (AGE) is higher

[11] A separate table of sample statistics by all 14 DRGs is included as an appendix (Table 1A).

compared to non-mobile patients (approximately 58 years). Table 1 further suggests that length of stay (LOS) is considerably shorter (mean 4.11 days) for mobile patients than for others (with mean 7.31 days)[12].

In the complete data set, mean waiting time (WAIT_T1) for patients treated at their closest hospital is 174.4 days vs. 63.9 days for patients willing and able to travel[13]. In both categories 37% of stays is granted a maximum waiting time guarantee (WAIT_GUAR) by the government. For mobile patients the distance from home to next nearest hospital (DIST_NN) is also longer (131.0 km) than for non-migrating patients (107.7 km). This suggests that the proportion of patients living in less densely populated areas is somewhat higher in the group of mobile patients. The dependency between home municipality conditions and patient mobility is further reflected in the municipality level fraction of mobile elective patients (MIG_RATE). This fraction has a mean of only 4.31% for non-migrating patients, but 7.88% for mobile patients.

A more counter intuitive indication from Table 1 may be that the number of co-morbidities in the total is higher for mobile patients, with a mean 0.97 sub-diagnoses (SUB_DIAG) compared to 0.65 for other patients. This trait is also reflected in the higher number (2.17) of received procedures (SUR_PRO) per mobile patient as opposed to other patients receiving a mean of 1.49 procedures[14].

Among patients treated at their closest hospitals, state owned hospitals at different levels of care are responsible for 100% of all stays. For mobile patients the public hospitals only take care of about 23% of stays, as the stays in private sector hospitals (PRIV_DUM) amount to 77% of all stays.

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[12] Shorter mean LOS for mobile patients is also evident in 12 of 14 DRGs in the sample.
[13] Shorter mean WAIT_T1 for mobile patients is also evident in 10 of 14 DRGs in the sample.
[14] Higher mean SUB_DIAG for mobile patients is evident in only 3 of 14 DRGs in the sample.
Higher mean SUR_PRO for mobile patients is evident in 7 of 14 DRGs in the sample.

Patients living in the capital and largest city Oslo constitute a higher proportion of the non-migrating patients (8.24%) than they do of the mobile patients (1.03%). The dummy variables for year of hospital stay (DUM99 to DUM02) indicate an increasing proportion of mobile patients. The total number of observations is also increasing year by year.

(Table 2 around here)

4 Econometric framework

make the problem of signing the selectivity bias equivalent to an omitted- This section presents the econometric framework we use to examine the impact of patient mobility on waiting time and length of stay. One obvious concern is whether migration status is endogenous, that patients self-select into the migrating group. Individuals with a lower 'anxiety' level or lower threshold for leaving familiar circumstances to receive treatment elsewhere, either innate or due to circumstances of their day-to-day situation, would be more likely to migrate and possibly experience shorter waiting times. Such an 'anxiety' threshold is, of course, unobserved. Furthermore, if the error term in our migration model is correlated with this threshold, and the error term in our waiting time equation is correlated with the threshold, then the two terms should be positively correlated. These conditions variable problem.

It follows that we need to instrument for migrating status. Generally, instrumental variables estimation requires a variable that is correlated with the endogenous variable, uncorrelated with the error term, and does not affect the outcome of interest conditional on the included regressors. In the migration equation, we need a variable that is correlated with probability of migrating but does not affect waiting time (and length of stay). One plausible candidate is the yearly ratio of migrating patients to all treated patients across all diagnoses living in patient *i*'s municipality. We find a correlation coefficient of .32 between the municipality migration ratio and the patient migration dummy. The municipality migration ratio may affect patient *i*'s probability of migrating because the higher is this ratio, the more likely it is that patient *i* migrates. A relative high ratio indicates a relative strong penetration of the free choice possibilities creating a possible self-enforcing 'herding' behaviour among patients. Thus, compared to a municipality with relatively few migrating patients, the threshold for migrating is lower in a municipality with relatively many migrating patients.

Furthermore, it is reasonable to argue that the ratio should not affect waiting time for a particular patient with a particular DRG treated at a hospital of free choice 'somewhere in the country'[15]. Importantly too, we find only weak correlation between the migrating ratio and (i) number of comorbidities (correlation coefficients .015) and surgical procedures received (correlation coefficient .011); (ii) travel distance between home municipality and hospital at which treatment is given (correlation coefficient .017) and (iii) age (correlation coefficient .062). This indicates that it is unlikely that the migrating ratio is strongly correlated with unobserved frailty or unobserved health status. Consequently, the migrating ratio is included as an explanatory variable in the migrating probability equation but not in the waiting time and length of stay equations.

Obviously, the 'appropriate' econometric model depends on how we believe patient mobility affects waiting times. Our approach is to apply two different types of model: (i) a treatment effects model in which migrating status has only an intercept effect on waiting times and (ii) a sample selection model in which migrating status has both a slope effect and an intercept effect on waiting times.

[15] The correlation coefficient between migrating ratio and waiting time is .086.

Treatment effects model

The treatment effects model estimates the effect of an endogenous binary treatment M_i on a continuous, fully observed variable *waittime* $_i$, conditional on the independent variables x_i and z_i. The treatment effects model includes migrating status as a right-hand side dummy variable, and pools the entire sample of migrating and non-migrating patients. The gain from migrating is common for all migrating patients.

A waiting time equation that accounts for the value of migrating is

$$waittime_i = \beta' x_i + \delta M_i + \varepsilon_i \qquad (1)$$

where M_i is an endogenous dummy variable indicating whether or not the individual migrates. The binary decision to migrate is modelled as the outcome of an unobserved latent variable, M_i^*. It is assumed that M_i^* is a linear function of the exogenous covariates z_i and a random component u_i:

$$M_i^* = \gamma' z_i + u_i \qquad (2)$$

The observed decision is

$$M_i = \begin{cases} 1, if M_i^* > 0 \\ 0, otherwise \end{cases}$$

We suppose that u_i and ε_i are correlated and have a bivariate normal distribution with zero means and correlation ρ. The covariate matrix is $\begin{bmatrix} \sigma & \rho \\ \rho & 1 \end{bmatrix}$.

The treatment effects model allows us to correct for selectivity. If the treatment effects model is correct, the least squares estimates of δ is biased.

Expected waiting time for migrating patients is given by[16]

$$E[waittime_i | M_i = 1] = \beta' x_i + \delta + E[\varepsilon_i | M_i = 1] = \beta' x_i + \delta + \rho\sigma_\varepsilon \lambda(\gamma' w_i) \tag{3}$$

For non-migrating patients, the counterpart to (3) is

$$E[waittime_i | M_i = 0] = \beta' x_i + \rho\sigma_\varepsilon \left[\frac{-\phi(\gamma' w_i)}{1 - \Phi(\gamma' w_i)} \right] \tag{4}$$

The difference in expected waiting time between migrating and non-migrating patients is, then,

$$E[waittime_i | M_i = 1] - E[waittime_i | M_i = 0] = \delta + \rho\sigma_\varepsilon \left[\frac{\phi_i}{\Phi_i (1 - \Phi_i)} \right] \tag{5}$$

If the correlation between the error terms, ρ, is zero, then the problem of finding the effect of migrating on waiting time reduces to one estimable by OLS and the difference is simply δ.

[16] See, for example, Greene (1997), chap. 20.

Heckman selection correction model

In the Heckman selection correction model, the sample is split into migrating and non-migrating patients. Then a waiting time equation is estimated for each sub-sample. According to this type of model, migrating status does not show up as a dummy variable but rather in the fact that the constant term and betas may differ between the migrating and non-migrating sample. In other words, the model allows for heterogeneity in the response of migrating on waiting times. Essentially, this model allows a full set of interaction terms between migrating status and the covariates/explanatory variables. The regression equation for each sub-sample is

$$waittime_{Mi} = \beta_M^{'} x_i + \varepsilon_{Mi} \quad (7)$$

and

$$waittime_{NMi} = \beta_{NM}^{'} x_i + \varepsilon_{NMi}$$

where the subscript *M* denotes a migrating patient and *NM* a non-migrating patient.

The selection or migration equation is given by

$$\lambda' z_i + u_i > 0 \quad (8)$$

where

$$\varepsilon_M \sim N(0, \sigma)$$

$$\varepsilon_{NM} \sim N(0, \sigma)$$

$$u_i \sim N(0,1)$$

$$corr(\varepsilon_M, u_i) = \rho_M$$

$$corr(\varepsilon_{NM}, u_i) = \rho_{NM}$$

When $\rho_M \neq 0$ and/or $\rho_{NM} \neq 0$, OLS regression applied to equations (7) yield biased results. The Heckman selection correction model provides consistent, asymptotically efficient estimates for all the parameters in such models.

Length of stay equation

Assuming that the difference between expected waiting time at a patient's nearest hospital and the expected waiting time at other possible institutions outside the region is the driving force behind the migrating decision and given that patients trade off the disutility of migrating against gains in waiting time, one should expect to find shorter average waiting times for migrating patients. However, the posted waiting times on web-based service are our measure of expected waiting times. Thus, it is possible that some migrating patients actually experience a longer waiting time compared to expected waiting time at their nearest hospital. Secondly, if the migrating patients are, say, generally less frail compared to non-migrating patients this may affect both waiting time and length of stay across samples. Thus, the possible cause-effect relationship between waiting time and length of stay needs to be considered. The length of stay equation is modelled as

$$los_i = \nu' w_i + \delta M_i + \kappa_i \tag{6}$$

where w_i is a vector of characteristics including predicted waiting time for patient i based on Heckman selection correction model estimates. M_i is here an exogenous dummy variable indicating whether or not the individual migrates. κ_i is the residual for patient i.

5 Results

The main aim of this study to answer three questions concerning the effect of patient mobility:

Q1: Do migrating patients have different characteristics compared to non-migrating patients?

Q2: Do migrating patients experience shorter waiting times compared to patients treated at their nearest hospital?

Q3: Do migrants experience shorter length of stay compared to patients choosing to be treated at their nearest hospital?

We will address the questions in turn. Question 1 is addressed using probit estimates of the probability of migrating. Question 2 is addressed discussing the results from both the treatment effects model and the Heckman selection correction model. These two models are estimated using both a maximum likelihood estimator (MLE) and a two-step estimator (TSE). Finally, question 3 is addressed discussing the results from ordinary least square (OLS) estimation of the length of stay equation using predicted probabilities of migrating and dummy variable specification indicating migration or not. The predicted waiting times[17] are

[17]The reason for using predicted waiting times rather then actual waiting times is based on an augmented regression test of endogeneity (Davidson and McKinnon (1993)) between waiting time and length of stay. The test shows that the instrumental variables estimator is a consistent estimator in the length of stay equation.

based on the Heckman selection correction model estimates.

Do migrating patients have different characteristics compared to non-migrating patients?

Table 3 shows that gender (GENDER) has no significant effect on the probability of migrating. Increasing age (AGE) reduces the mobility of patients as expected. The marginal effect is small, though. Distance to next nearest hospitals (DIST_NN) has a significant negative effect on the probability of migrating, which is somewhat surprising. A priori, one would expect that the shorter is the distance to next nearest hospital, the less mobile patients would turn out to be. On the other hand, a 'higher density' of hospitals may increase patient mobility because people are more accustomed to choose a different hospital than the nearest one. Under any circumstances, the marginal effect is quite small.

(Table 3 about here)

Having status as a waiting time guarantee patient (WAIT_GUAR) is clearly not influential in the migrating decision, possibly reflecting that status as a guarantee patient mutes the incentives to migrate in the first place. The sign is as expected, i.e. status as a guarantee patient reduces patient mobility as defined here since a guarantee patient is given a fixed waiting time that is binding for the hospital that admits the patient.

The instrument (MIG_RATE) has a strong positive effect on the probability of migrating, as discussed in Section 4. Number of sub-diagnoses (SUB_DIAG) reduces the probability of migrating and likewise number of surgical procedures (SUR_PRO). The marginal effect for the latter is, however, smaller compared to SUB_DIAG. Interpreting SUB_DIAG and

SUR_PRO as indicators of severity, both signs are as expected. The more severe the illness, the less mobile is the patient.

Table 3 also shows that the probability of migrating increases over time. Compared to 1999 the probability of migrating is higher in 2002 (DUM_02) and 2001 (DUM_01). This result indicates that the free choice policy has increased patient mobility. We find no significant change in the probability of migrating in 2000 (DUM_00) compared to 1999.

We also find that patients classified under DRG_209 have a smaller probability of migrating compared to all other DRGs, with the exception of DRG_215 (less likely to migrate) and DRG_243 (non-significant), as expected from sample statistics reported in Table 2.

Do migrating patients experience shorter waiting times compared to patients treated at their nearest hospital?

Let us address the question whether an OLS estimate of MOB_DUM is a consistent estimate of the marginal effect of patient mobility on waiting time (equation (1)).

(Table 4 about here)

Commenting first on the treatment effects model, note that the likelihood-ratio test reported at the bottom of the table indicates that we can reject the null hypothesis that the error term in our model for migrating and the error term in our waiting time equation is uncorrelated. We conclude that an OLS estimate of MOB_DUM is not a consistent estimate of the marginal effect of migrating on waiting time.

Furthermore, rho is positive indicating that the OLS estimate would underestimate patient mobility waiting time gain. The so called selectivity effect (lambda) is approximately 19 days meaning that unobserved heterogeneity relegated to the error terms drives waiting time up with 19 days.

The estimation results from the treatment effects model indicate also that patient mobility matters. The coefficient for MOB_DUM shows that mobile patients wait, on average, approximately 104 days shorter than non-migrating patients who receive treatment at their nearest relevant hospital. The two-step estimate is approximately 6 days below the MLE estimate. The overall picture is that the MLE estimates and two-step estimates are well aligned. Thus, in what follows we comment only on the MLE estimates.

The mean predicted waiting time differentials between the 'treated' and the 'non-treated' is minus 65.7 days for the MLE case and minus 66.3 days in the TSE case (not reported in the table). Thus, the difference in waiting time is on average about two months.

Furthermore, Table 4 shows that gender does not matter for waiting time. Age does, but only at a ten percent level of significance and the effect is small. Having status as a waiting time guarantee patient reduces waiting time with approximately 50 days compared to not having status as a guarantee patient. Number of comorbidities (SUB_DIAG) also significantly reduces waiting times. The effect is a shorter waiting time per registered comorbidity of approximately 9 days. Number of procedures received (SUR_PRO) has the opposite effect. Waiting time increases with 2.5 days per procedure received.

Patients living in the capital, Oslo (CAP_DUM), wait on average 41 days less than patients from elsewhere in the country. The dummy variable indicating at which type of institution the patient is treated (PRIV_DUM with public hospitals as base) shows that patients treated at private hospitals wait approximately 36 days longer for treatment compared to patients treated at public hospitals.

Across all patients, there is an increase in waiting time over time. The introduction of free choice in 2001 does not change this conclusion. As a matter of fact, the average waiting time in 2002 is approximately 5 days longer compared to 1999. This must be a discouraging result as seen from the government's point of view. However, as already discussed, migrating patients wait on average two months less for treatment compared to non-migrating patients. Thus, patient mobility pays off and that must be encouraging for policymakers.

Table 4 also shows, as expected, that different DRGs imply different waiting times. The base is DRG 209. The other DRGs, expect DRG 222, have shorter waiting times compared to DRG 209. The difference spans from 131 days (DRG_140) to 10 days (DRG_241). Patients classified in DRG 222 wait approximately 9 days longer than patients classified in DRG 209.

Turning to the results of the Heckman selection model (Table 5), and reporting only the ML estimates, notice that the likelihood-ratio tests indicate that we can reject the null hypotheses that the error terms in the equations for migrating and not-migrating and the error terms in the supporting waiting time equations are uncorrelated. We conclude that OLS estimates of MOB_DUM based on either of the two samples are not consistent estimates of the marginal effects of migrating status on waiting time.

(Table 5 about here)

We also find that the rhos are negative indicating that OLS estimates of the MOB_DUM for the two samples would overestimate the effect of migrating/non-migrating. The selectivity effect (lambda) is minus 4.5 days in the case of migrating patients and minus 27 days for non-migrating patients. But, more importantly, the net selectivity effect is approximately 22.5 days (compared to 19 days in the treatment effects model).

The difference between the constant terms in the migrating and non-migrating case, i.e. the difference in waiting time evaluated at $x_i = 0$, is approximately 146 days indicating almost 5 months shorter average waiting time for migrating patients compared to non-migrating patients. The mean predicted (not reported in the table) waiting time is 97.5 days for the migrating sample and 164 days for the non-migrating sample, an average difference of close to 70 days.

As pointed out above, migrating status does not show up as a dummy variable but rather in the fact that the constant term and betas may differ from the migrating to the non-migrating sample. In other words, the model allows for heterogeneity in the response of migrating on waiting times and allows a full set of interaction terms between migrating status and the covariates.

Table 5 shows that both gender and age are significant for the migrating sample. Men wait less than women, and the older a patient, the longer the waiting time. For the non-migrating sample, men wait approximately 4.5 days longer then women, while age has a non-significant effect on waiting time. Status as a guarantee patient (WAIT_GUAR) significantly reduces waiting time and more so for the non-migrating sample. Number of comorbidities (SUB_DIAG) is not significant for the migrating sample but reduces waiting time with approximately 11 days per registered comorbidity for the non-migrating sample. The marginal effect of surgical procedures (SUR_PRO) is positive and increases waiting times for the migrating sample with approximately 5.5 days per procedure. SUR_PRO is not significant for the non-migrating sample. Patients belonging to the municipality of Oslo, the capital, experiences shorter waiting times compared to other patients. The effect is strongest for the non-migrating sample.

Migrating patients who choose to be treated at private clinics wait 50 days less than patients treated at public hospitals. Another striking result is that waiting times for both migrating and non-migrating patients increases over time. The time effect is strongest for migrating patients. Compared with 1999, migrating patients wait close to 16 days longer for treatment in 2002 (DUM02). For non-migrating patients, the effect is only 5 days.

Both size and sign of the DRG dummies differ across the two samples, which is also a notable feature of the coefficients discussed above. Since the betas differ across migrating status, we have an indication that the Heckman selection correction model is more efficient than the treatment effects model.

Do migrants experience shorter length of stay compared to patients choosing to be treated at their nearest hospital?

Table 6 shows that estimated waiting time (EST_WAIT) reduces length of stay but the coefficient is very small. The negative effect on length of stay of one more day of waiting is 'close to zero'. The migrating dummy (MOB_DUM) is negative and indicates that migrating patients on average stay one day less in hospital compared to non-migrating patients. This result is interesting because the potential waiting time gains to increased patient mobility is not countered by an increase in length of stay for these patients. Predicted mean length of stay for migrating patients is 4.1 days and 7.3 days for non-migrating patients (not reported in the table).

(Table 6 about here)

Men (GENDER) have a shorter length of stay than women and age (AGE) increases length of stay, as one would expect. Number of comorbidities (SUB_DIAG) and number of surgical procedures received (SUR_PRO) increase length of stay, also as expected. Patients treated at a private hospital (PRIV_DUM) experience approximately a one day shorter stay than patients treated at public hospitals. Patients belonging to the municipality of Oslo (CAP_DUM) stay approximately one day less than other patients.

Length of stay decreases over time. Patients admitted to hospital in 2002 stay in hospital about one day less than patients admitted in 1999.

Day of admittance also seems to matter. Most notably, patients admitted on Fridays stay approximately one and a half days longer than patients admitted on Mondays. This result can be explained by a weekend effect, i.e. hospitals are staffed for less activity over weekends than on weekdays.

Finally, as expected, patients grouped in DRG_209 (major joint and limb reattachment procedures of lower extremity) stay longer in hospital than all other patients/DRGs.

6 Discussion

Patient mobility is stimulated by the free choice policy implemented by Norwegian health authorities in 2001. Although it may be too soon to make a verdict on the policy's effect on degree of competition between hospitals, allowing for patient mobility on a national level has a positive effect on waiting times for migrating patients. Compared to non-migrating patients, migrating patients wait, on average, two months less for treatment. Furthermore, it is interesting to register that waiting times increase over time and more so for patients choosing to be treated elsewhere than at their nearest hospital. This finding complies with a hypothesis that competition between hospitals will over time result in a convergence of waiting times across hospitals.

We also find indications that it is the comparatively young and less complicated patients that are mobile. Notably, average length of stay is shorter for migrating patients than for non-migrating patients. It is also interesting to note that private hospitals offer both shorter waiting times and shorter length of stay than public hospitals preferred by migrating patients. The latter point leads us to ask whether private hospitals treat the less complicated cases amongst the migrating sample of patients, just as, as pointed out above, our sample of migrating patients tends to be less complicated than our non-migrating patients. However, using the dimensions age, number of comorbidities and number of surgical procedures as indicators[18] of patients' complexity or 'lightness', we find a small positive effect of age on the probability of migrating patients being treated at a private than a public hospital (marginal effect of .005) and a positive marginal effect of number of comorbidities (coefficient of .04). Number of surgical procedures reduces the probability of being treated at a private clinic. In sum, the evidence is not clear that potentially less complicated patients choose private clinics. On the other hand, we find no increased probability over time that patients choose private but the majority of mobile patients in our sample do choose private. The reason private hospitals seem to be competitive is not dealt with explicitly in this study but we know that private hospitals do not take emergency cases and they have no responsibility for training newly educated surgeons, both important tasks for many public hospitals. Private hospitals are typically smaller and more specialized, compared to 'all purpose' public hospitals. This in turn may have consequences for other quality dimensions not dealt with in this study but which may be important factors when patients decide whether to migrate or not.

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[18] Results of the probit estimation of the probability of choosing private vs public, given status as migrating patients, is not reported in the table.

7 Concluding remarks

The discussion leads us to conclude that given the institutional status quo 'setting' of the hospital sector in Norway, competition between hospitals will increase over time, not only between public hospitals but even more so between private and public hospitals. As mentioned earlier, up until mid-2004, the social security system covered patients' travelling expenses. From mid-2004, the regional health authorities have to cover travelling expenses in addition to treatment costs for patients that choose to be treated outside their health region. Regional health authorities are motivated to minimize 'export' of patients and maximize 'import' as travelling costs now are internal. The way to decrease the number of 'emigrants' and increase the number of 'immigrants' is to reduce waiting times and increase performance along other quality dimensions also transparent to patients and GPs. Thus, competition between hospitals may become stronger in the years to come, particularly where there is excess supply. On the other hand, regional health authorities may have incentives to collude with the aim of reducing patient flows between regions. This collusion hypothesis is, perhaps, a frail one but cannot be dismissed altogether. However, it is harder to see how regional health authorities can collude with private clinics with the aim of reducing the flow to these clinics. One possible way would be to make it harder for private clinics to contract with the the regional health authorities. These latter points are themes for further research.

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Tables

Table 1. Sample statistics. All hospital stays by patient mobility, across all 14 DRGs and years 1999–2002.

	Stays of patients treated at nearest hospital (N=38,703)				Inter regional mobile patients' stays (N=17,048)			
	Minimum	Maximum	Mean	Std. Dev.	Minimum	Maximum	Mean	Std. Dev.
GENDER	0	1	.50	.500	0	1	.69	.464
AGE	0	101	58.55	18.569	0	97	61.03	13.260
LOS	1	60	7.31	6.286	1	43	4.11	3.531
WAIT_T1	1	1433	174.3845	163.37589	1	681	63.9003	60.50440
WAIT_GUAR	0	1	.37	.482	0	1	.37	.483
DIST_NN	0	1270.40	107.6943	118.86464	0	1936.20	131.0139	121.83296
MIG_RATE	0	.59	.0431	.04327	0	.59	.0788	.06415
SUB_DIAG	0	7	.65	1.079	0	7	.97	1.051
SUR_PRO	0	10	1.49	1.503	0	10	2.17	1.348
PRIV_DUM	0	0	0	0	0	1	.77	.420
CAP_DUM	0	1	.0824	.27505	0	1	.0103	.10108
DUM99	0	1	.1834	.38704	0	1	.1426	.34967
DUM00	0	1	.2505	.43331	0	1	.2386	.42622
DUM01	0	1	.2820	.44999	0	1	.2975	.45718
DUM02	0	1	.2840	.45096	0	1	.3213	.46700

AGE = Age in years;

DIST_NN = Distance from patients home municipality to next nearest hospital supplying DRG as in actual stay;

DUM99 to DUM02 = Hospital stay year dummy variables: actual year:1;

GENDER = Female:0, Male:1;

LOS = Length of stay in days;

MIG_RATE = Fraction inter-regional mobile patients of all elective stays, in patient's home municipality;

CAP_DUM = Capitol Oslo home county of patient:1;

PRIV_DUM = Hospital stay in privately owned hospital:1;

SUB_DIAG = Number of sub-diagnosis registered;

SUR_PRO = Number of surgical procedures performed;

WAIT_GUAR = Waiting list time guarantee:1;

WAIT_T1 =Waiting time from referral to hospital admittance in days;

Table 2. Hospital stays by patient mobility and DRG, across all years 1999–2002.

DRG	Stays of patients treated at nearest hospital (N=38 703)		Inter regional mobile patients' stays (N=17 048)		Total hospital stays (N=55 751)	
105	386	33.1 %	781	66.9 %	1,167	100.0 %
107	1,034	22.2 %	3,621	77.8 %	4,655	100.0 %
112	1,151	24.9 %	3,476	75.1 %	4,627	100.0 %
132	241	9.0 %	2,436	91.0 %	2,677	100.0 %
133	288	13.4 %	1,864	86.6 %	2,152	100.0 %
140	506	55.1 %	412	44.9 %	918	100.0 %
143	119	10.4 %	1,020	89.6 %	1,139	100.0 %
162	2,897	90.7 %	296	9.3 %	3,193	100.0 %
209	14,441	94.4 %	851	5.6 %	15,292	100.0 %
215	4,768	94.3 %	287	5.7 %	5,055	100.0 %
222	3,178	90.9 %	320	9.1 %	3,498	100.0 %
241	2,336	78.0 %	658	22.0 %	2,994	100.0 %
243	2,867	94.2 %	177	5.8 %	3,044	100.0 %
35	4,491	84.1 %	849	15.9 %	5,340	100.0 %
Total	38,703	69.4 %	17,048	30.6 %	55,751	100.0 %

DRG descriptors (source: http://norddrg.kuntaliitto.fi/manual_2001/)

105 Cardiac valve procedures w/o cardiac cath

107 Coronary bypass w/o cardiac cath

112 Percutaneous cardiovascular procedures

132 Atherosclerosis w cc

133 Atherosclerosis w/o cc

140 Angina pectoris

143 Chest pain

162 Inguinal & femoral hernia procedures, age > 17 w/o cc

209 Major joint & limb reattachment procedures of lower extremity

215 Back & neck procedures w/o cc

222 Knee procedures w/o cc

241 Connective tissue disorders w/o cc

243 Medical back problems

35 Other disorders of nervous system w/o cc

Table 3. Probability of migrating. Probit estimates. Marginal effects.

	Marginal effect		S.E.
GENDER(*)	0.00822		0.00507
AGE	–0.00129	***	0.00016
DIST_NN	–0.00023	***	0.00001
WAIT-GUAR(*)	–0.00204		0.00494
MIG_RATE	2.37977	***	0.04409
SUB_DIAG	–0.04137	***	0.00241
SUR_PRO	–0.00832	***	0.00206
DUM_00(*)	0.04973		0.00772
DUM_01(*)	0.02958	***	0.00763
DUM_02(*)	0.05987	***	0.00766
DRG_105(*)	0.74121	***	0.00548
DRG_107(*)	0.79773	***	0.00381
DRG_112(*)	0.76578	***	0.00437
DRG_132(*)	0.79712	***	0.00290
DRG_133(*)	0.76898	***	0.00384
DRG_140(*)	0.58308	***	0.01343
DRG_143(*)	0.76437	***	0.00393
DRG_162(*)	0.07323	***	0.01308
DRG_215(*)	–0.03136	***	0.01073
DRG_222(*)	0.05538	***	0.01356
DRG_241(*)	0.32696	***	0.01354
DRG_243(*)	–0.01513		0.01369
DRG_35(*)	0.16292	***	0.12488
N=55,751			
Likelihood ratio			
chi2(23)=34137.05			

Pseudo R2= 0.49
Obs. P = 0.303
Pred. P = 0.23 (at x-bar)

(*) Marginal effect is for discrete change of dummy variable from 0 to 1.

*** Significant at 1 percent level.

Table 4. Waiting time. Treatment Effects Model. Maximum likelihood (MLE) and two-step estimates (TSE).

	MLE			TSE		
	COEF.		S.E.	COEF.		S.E.
GENDER	1.77		1.23	1.75		1.23
AGE	0.07	*	0.04	0.08	*	0.04
WAIT_GUAR	–50.81	***	1.20	–50.74	***	1.20
SUB_DIAG	–8.95	***	0.58	–8.81	***	0.59
SUR_PRO	2.48	***	0.53	2.54	***	0.53
CAP_DUM	–41.17	***	2.61	–41.08	***	2.62
PRIV_DUM	36.64	***	3.29	35.20	***	3.34
DUM_00	–3.89	**	1.76	–3.93	**	1.76
DUM_01	–0.39		1.73	–0.56		1.73
DUM_02	5.00	***	1.73	4.69	***	1.74
DRG_105	–112.10	***	5.05	–115.23	***	5.41
DRG_107	–117.91	***	3.99	–121.43	***	4.56
DRG_112	–100.19	***	3.74	–103.59	***	4.29
DRG_132	–90.52	***	4.58	–94.57	***	5.23
DRG_133	–99.28	***	4.58	–103.03	***	5.14
DRG_140	–131.29	***	4.84	–133.15	***	4.98
DRG_143	–91.85	***	5.34	–95.73	***	5.86
DRG_162	–71.17	***	2.67	–71.28	***	2.67
DRG_215	–79.91	***	2.35	–79.78	***	2.35
DRG_222	8.82	***	2.80	8.71	***	2.79
DRG_241	–9.85	***	2.90	–10.73	***	2.94
DRG_243	–88.12	***	2.88	–87.93	***	2.88
DRG_35	–46.10	***	2.64	–46.46	***	2.65
MOB_DUM	–104.36	***	4.59	–98.18	***	5.77
CONSTANT	234.97	***	3.51	234.30	***	3.53

	MLE		TSE		
	COEF.	S.E.	COEF.		S.E.
Rho	0.15	0.02	0.12		
Sigma	130.44	0.40	130.31		
Lambda	18.87	2.18	15.54	***	2.92
	N=55,751		N=55,751		
	Wald		Wald		
	chi2(24)=16,990.60		chi2(45)=37,363.05		
	LR test of indep.				
	eqns.: chi2(1)=				
	48.30				

*** Significant at 1 percent level. ** Significant at 5 percent level.

* Significant at 10 percent level.

Table 5. Waiting time. Heckman Selection Correction Model. Maximum likelihood estimates (MLE).

	MIGRATING			NON-MIGRATING		
	COEF.		S.E.	COEF.		S.E.
GENDER	–3.69	***	0.91	4.42	***	1.68
AGE	0.17	***	0.04	0.08		0.05
WAIT-GUAR(*)	–18.29	***	0.96	–63.41	***	1.67
SUB-DIAG	–0.35		0.44	–10.71	***	0.79
SUR_PRO	5.42	***	0.43	–0.11		0.74
CAP_DUM	–22.37	***	3.93	–36.44	***	3.25
PRIV_DUM	–50.44	***	2.57			
DUM_00	–1.09		1.44	0.73		2.37
DUM_01	3.99	***	1.42	4.52	**	2.33
DUM_02	15.90	***	1.35	5.03	**	2.36
DRG_105	–36.96	***	3.89	–89.56	***	8.57
DRG_107	–39.68	***	3.56	–95.36	***	5.91
DRG_112	–12.07	***	3.28	–106.45	***	5.60
DRG_132	3.06		3.55	–119.08	***	10.72
DRG_133	2.64		3.62	–139.32	***	9.76
DRG_140	–7.95	**	4.12	–147.27	***	7.15
DRG_143	5.47		3.79	–136.46	***	14.41
DRG_162	–24.41	***	3.51	–76.43	***	3.29
DRG_215	–8.59	**	3.58	–84.23	***	2.87
DRG_222	59.68	***	3.65	6.48	*	3.45
DRG_241	13.69	***	2.86	–4.23		3.74
DRG_243	3.51		4.34	–97.09	***	3.55
DRG_35	–7.08	***	2.74	–55.93	***	3.40

CONSTANT	97.88	***	3.66	244.50	***	4.56
Rho	–0.88		0.02	–0.18		0.02
Sigma	51.11		0.28	151.74		0.56
Lambda	–4.50		0.79	–27.29		2.58
	N=55,751			N=55,751		
	Censored			Censored		
	obs=38,703			obs=17,048		
	Uncensored			Uncensored		
	obs=17,048			obs=38,703		
	Wald			Wald		
	chi2(23)=5,694.36			chi2(22)=5,299.98		
	LR test of indep.			LR test of indep.		
	eqns.: chi2(1)=			eqns.: chi2(1)=		
	30.81			79.35		

*** Significant at 1 percent level. ** Significant at 5 percent level.

* Significant at 10 percent level.

Table 6. Length of stay. Ordinary least square estimates (OLS).

	COEF.		S.E.
EST_WAIT	–0.01	***	0.00
MIG_DUM	–1.01	***	0.10
GENDER	–0.27	***	0.04
AGE	0.03	***	0.00
WAIT_GUAR	0.04		0.07
SUB_DIAG	0.78	***	0.02
SUR_PRO	0.27	***	0.02
CAP_DUM	–0.93	***	0.09
PRIV_DUM	–0.91	***	0.10
DUM00	–0.28	***	0.05
DUM01	–0.48	***	0.05
DUM02	–0.99	***	0.05
TUE_DUM	–0.07		0.05
WED_DUM	–0.10	**	0.05
THU_DUM	0.41	***	0.06
FRI_DUM	1.63	***	0.06
SAT_DUM	0.09		0.19
SUN_DUM	–0.14	**	0.07
DRG_105	–3.13	***	0.18
DRG_107	–3.77	***	0.16
DRG_112	–9.42	***	0.14
DRG_132	–9.66	***	0.15
DRG_133	–9.04	***	0.16
DRG_140	–9.75	***	0.20
DRG_143	–9.22	***	0.17
DRG_162	–8.80	***	0.11
DRG_215	–4.97	***	0.11
DRG_222	–7.04	***	0.08

DRG_241	–3.57	***	0.09
DRG_243	–7.69	***	0.13
DRG_35	–8.48	***	0.09
CONSTANT	11.04	***	0.28
N=55,751			
F(31.55719)=			
2,188.86			
R-squared=0.55			

*** Significant at 1 percent level. ** Significant at 5 percent level. * Significant at 10 percent level.

Appendix

Table A1. Sample statistics. Hospital stays by DRG and patient mobility, across all years 1999–2002.

		Stays of patients treated at closest hospital (N=38 703)				Inter-regional mobile patients' stays (N=17 048)			
DRG		Min.	Max.	Mean	Std Dev.	Min.	Max.	Mean	Std Dev.
105	(n= 1 167)								
	GENDER	.00	1.00	.57	.50	.00	1.00	.62	.49
	AGE	8.00	87.00	67.02	13.54	17.00	89.00	70.38	10.92
	LOS	2.00	59.00	13.47	7.63	1.00	25.00	8.25	1.95
	WAIT_T1	1.00	216.00	75.18	52.82	1.00	178.00	36.18	33.34
	WAIT_GUAR	.00	1.00	.48	.50	.00	1.00	.50	.50
	DIST_NN	.00	1,270.40	372.66	341.43	.00	1,907.10	142.61	150.60
	MIG_RATE	.00	.12	.01	.01	.00	.59	.08	.05
	SUB_DIAG	.00	7.00	2.41	2.16	.00	7.00	1.41	1.38
	SUR_PRO	2.00	10.00	5.61	1.60	1.00	10.00	3.62	1.80
	PRIV_DUM	.00	.00	.00	.00	.00	1.00	.99	.11
	CAP_DUM	.00	1.00	.37	.48	.00	1.00	.01	.10
	DUM99	.00	1.00	.10	.30	.00	1.00	.09	.29
	DUM00	.00	1.00	.18	.38	.00	1.00	.18	.38
	DUM01	.00	1.00	.35	.48	.00	1.00	.36	.48
	DUM02	.00	1.00	.37	.48	.00	1.00	.38	.48
107	(n= 4 655)								
	GENDER	.00	1.00	.82	.38	.00	1.00	.81	.39
	AGE	31.00	86.00	63.96	9.66	30.00	90.00	65.29	9.79
	LOS	1.00	57.00	10.65	5.27	1.00	29.00	7.86	1.49
	WAIT_T1	1.00	224.00	74.91	54.72	1.00	192.00	28.35	34.93
	WAIT_GUAR	.00	1.00	.51	.50	.00	1.00	.52	.50
	DIST_NN	.00	1,270.40	449.16	353.66	.00	1,936.20	178.45	175.59

	MIG_RATE	.00	.13	.01	.01	.00	.59	.07	.05
	SUB_DIAG	.00	7.00	1.46	1.51	.00	7.00	1.28	1.33
	SUR_PRO	1.00	10.00	4.52	1.50	1.00	9.00	3.20	1.22
	PRIV_DUM	.00	.00	.00	.00	.00	1.00	1.00	.07
	CAP_DUM	.00	1.00	.28	.45	.00	1.00	.00	.06
	DUM99	.00	1.00	.15	.35	.00	1.00	.10	.30
	DUM00	.00	1.00	.24	.43	.00	1.00	.26	.44
	DUM01	.00	1.00	.32	.47	.00	1.00	.31	.46
	DUM02	.00	1.00	.29	.46	.00	1.00	.33	.47
112	(n= 4 627)								
	GENDER	.00	1.00	.72	.45	.00	1.00	.74	.44
	AGE	.00	89.00	60.06	14.15	7.00	90.00	60.89	11.95
	LOS	1.00	37.00	2.22	1.98	1.00	15.00	2.00	.85
	WAIT_T1	1.00	266.00	76.69	51.10	1.00	285.00	60.24	47.97
	WAIT_GUAR	.00	1.00	.18	.39	.00	1.00	.30	.46
	DIST_NN	.00	599.50	93.46	110.95	.00	1,331.30	178.43	138.77
	MIG_RATE	.00	.07	.01	.01	.00	.59	.08	.05
	SUB_DIAG	.00	7.00	1.24	1.19	.00	6.00	1.07	.87
	SUR_PRO	1.00	10.00	3.24	2.15	1.00	7.00	2.33	.97
	PRIV_DUM	.00	.00	.00	.00	.00	1.00	.88	.32
	CAP_DUM	.00	1.00	.52	.50	.00	1.00	.00	.07
	DUM99	.00	1.00	.09	.28	.00	1.00	.15	.35
	DUM00	.00	1.00	.26	.44	.00	1.00	.24	.42
	DUM01	.00	1.00	.30	.46	.00	1.00	.29	.45
	DUM02	.00	1.00	.34	.48	.00	1.00	.33	.47
132	(n= 2 677)								
	GENDER	.00	1.00	.75	.43	.00	1.00	.74	.44
	AGE	38.00	93.00	69.33	9.63	30.00	94.00	65.08	10.07
	LOS	1.00	25.00	4.02	3.86	1.00	8.00	1.68	.58
	WAIT_T1	1.00	109.00	30.86	31.47	1.00	185.00	71.98	33.94

	WAIT_GUAR	.00	1.00	.37	.48	.00	1.00	.17	.38
	DIST_NN	.00	530.30	62.02	76.59	.00	530.30	85.33	43.00
	MIG_RATE	.01	.15	.04	.03	.00	.59	.08	.04
	SUB_DIAG	1.00	7.00	2.65	1.40	1.00	7.00	1.55	.74
	SUR_PRO	.00	5.00	.78	1.24	.00	6.00	1.99	.57
	PRIV_DUM	.00	.00	.00	.00	.00	1.00	1.00	.06
	CAP_DUM	.00	1.00	.37	.48	.00	1.00	.00	.05
	DUM99	.00	1.00	.11	.31	.00	1.00	.03	.16
	DUM00	.00	1.00	.17	.37	.00	1.00	.24	.43
	DUM01	.00	1.00	.30	.46	.00	1.00	.42	.49
	DUM02	.00	1.00	.43	.50	.00	1.00	.32	.47
133	(n= 2 152)								
	GENDER	.00	1.00	.72	.45	.00	1.00	.75	.43
	AGE	18.00	92.00	65.17	11.58	26.00	87.00	61.55	10.54
	LOS	1.00	22.00	2.75	2.94	1.00	11.00	1.76	.66
	WAIT_T1	1.00	106.00	28.06	29.14	1.00	180.00	61.03	32.03
	WAIT_GUAR	.00	1.00	.39	.49	.00	1.00	.46	.50
	DIST_NN	.00	505.00	59.56	69.38	.00	465.60	91.75	40.73
	MIG_RATE	.00	.17	.03	.03	.01	.55	.08	.04
	SUB_DIAG	.00	4.00	.99	1.01	.00	5.00	.46	.69
	SUR_PRO	.00	4.00	.39	.93	.00	4.00	1.81	.55
	PRIV_DUM	.00	.00	.00	.00	.00	1.00	1.00	.05
	CAP_DUM	.00	1.00	.40	.49	.00	1.00	.00	.06
	DUM99	.00	1.00	.22	.42	.00	1.00	.40	.49
	DUM00	.00	1.00	.20	.40	.00	1.00	.29	.46
	DUM01	.00	1.00	.30	.46	.00	1.00	.13	.34
	DUM02	.00	1.00	.28	.45	.00	1.00	.17	.37
140	(n= 918)								
	GENDER	.00	1.00	.69	.46	.00	1.00	.74	.44
	AGE	36.00	91.00	67.54	11.20	28.00	87.00	61.96	10.42

	LOS	1.00	37.00	3.25	3.60	1.00	8.00	1.57	.69
	WAIT_T1	1.00	211.00	41.06	45.40	1.00	145.00	50.21	41.11
	WAIT_GUAR	.00	1.00	.39	.49	.00	1.00	.34	.47
	DIST_NN	.00	517.40	116.74	132.63	.00	320.60	81.51	41.12
	MIG_RATE	.00	.52	.03	.04	.01	.59	.08	.07
	SUB_DIAG	.00	7.00	1.60	1.30	.00	4.00	.85	.88
	SUR_PRO	.00	6.00	.55	1.03	.00	4.00	1.80	.68
	PRIV_DUM	.00	.00	.00	.00	.00	1.00	.98	.14
	CAP_DUM	.00	1.00	.24	.42	.00	1.00	.00	.07
	DUM99	.00	1.00	.28	.45	.00	1.00	.01	.09
	DUM00	.00	1.00	.30	.46	.00	1.00	.69	.46
	DUM01	.00	1.00	.25	.43	.00	1.00	.17	.38
	DUM02	.00	1.00	.18	.38	.00	1.00	.13	.34
143	(n= 1 139)								
	GENDER	.00	1.00	.51	.50	.00	1.00	.40	.49
	AGE	.00	87.00	54.61	18.04	25.00	82.00	56.54	10.39
	LOS	1.00	11.00	2.23	1.79	1.00	14.00	1.59	.66
	WAIT_T1	1.00	151.00	34.08	30.01	1.00	187.00	68.98	35.56
	WAIT_GUAR	.00	1.00	.45	.50	.00	1.00	.37	.48
	DIST_NN	.00	620.40	151.31	154.00	.00	620.40	91.49	52.18
	MIG_RATE	.00	.44	.05	.06	.01	.55	.08	.04
	SUB_DIAG	.00	6.00	.66	1.02	.00	4.00	.79	.72
	SUR_PRO	.00	4.00	.69	.95	.00	3.00	1.93	.37
	PRIV_DUM	.00	.00	.00	.00	.00	1.00	1.00	.07
	CAP_DUM	.00	1.00	.11	.31	.00	1.00	.00	.06
	DUM99	.00	1.00	.19	.40	.00	1.00	.25	.43
	DUM00	.00	1.00	.26	.44	.00	1.00	.22	.41
	DUM01	.00	1.00	.32	.47	.00	1.00	.27	.44
	DUM02	.00	1.00	.23	.42	.00	1.00	.27	.44
162	(n= 3 193)								

	GENDER	.00	1.00	.90	.30	.00	1.00	.93	.25
	AGE	18.00	97.00	64.89	15.84	19.00	88.00	59.28	16.66
	LOS	1.00	28.00	2.77	1.51	1.00	6.00	2.19	.79
	WAIT_T1	1.00	685.00	156.46	131.04	1.00	391.00	82.99	64.00
	WAIT_GUAR	.00	1.00	.25	.43	.00	1.00	.08	.27
	DIST_NN	.00	620.40	105.69	83.42	.00	620.40	104.31	57.97
	MIG_RATE	.00	.59	.05	.05	.01	.45	.06	.05
	SUB_DIAG	.00	4.00	.28	.59	.00	3.00	.21	.54
	SUR_PRO	1.00	8.00	1.34	.82	1.00	7.00	1.40	.94
	PRIV_DUM	.00	.00	.00	.00	.00	.00	.00	.00
	CAP_DUM	.00	1.00	.00	.04	.00	1.00	.03	.17
	DUM99	.00	1.00	.23	.42	.00	1.00	.24	.43
	DUM00	.00	1.00	.25	.43	.00	1.00	.20	.40
	DUM01	.00	1.00	.28	.45	.00	1.00	.27	.44
	DUM02	.00	1.00	.24	.43	.00	1.00	.28	.45
209	(n= 15 292)								
	GENDER	.00	1.00	.29	.46	.00	1.00	.37	.48
	AGE	13.00	101.00	70.63	10.45	18.00	97.00	68.23	11.18
	LOS	1.00	60.00	11.95	5.96	1.00	43.00	11.21	4.21
	WAIT_T1	1.00	883.00	221.93	154.65	1.00	432.00	108.93	85.71
	WAIT_GUAR	.00	1.00	.33	.47	.00	1.00	.29	.46
	DIST_NN	.00	620.40	103.34	75.95	.00	530.30	109.86	67.72
	MIG_RATE	.00	.59	.05	.05	.00	.59	.09	.11
	SUB_DIAG	.00	7.00	.77	1.18	.00	6.00	.75	1.12
	SUR_PRO	1.00	10.00	1.72	1.12	1.00	9.00	1.60	1.08
	PRIV_DUM	.00	.00	.00	.00	.00	.00	.00	.00
	CAP_DUM	.00	1.00	.01	.12	.00	1.00	.02	.14
	DUM99	.00	1.00	.20	.40	.00	1.00	.13	.33
	DUM00	.00	1.00	.25	.43	.00	1.00	.19	.39
	DUM01	.00	1.00	.28	.45	.00	1.00	.32	.47

	DUM02	.00	1.00	.28	.45	.00	1.00	.36	.48
215	(n= 5 055)								
	GENDER	.00	1.00	.54	.50	.00	1.00	.59	.49
	AGE	1.00	91.00	47.53	14.62	11.00	83.00	46.84	14.94
	LOS	1.00	42.00	6.55	4.08	1.00	32.00	6.62	3.79
	WAIT_T1	1.00	582.00	132.91	116.03	1.00	407.00	96.05	88.05
	WAIT_GUAR	.00	1.00	.46	.50	.00	1.00	.44	.50
	DIST_NN	.00	517.40	87.96	61.53	.00	517.40	108.38	78.38
	MIG_RATE	.00	.59	.04	.04	.00	.59	.11	.15
	SUB_DIAG	.00	7.00	.22	.59	.00	4.00	.25	.59
	SUR_PRO	1.00	10.00	1.80	1.09	1.00	8.00	1.93	1.31
	PRIV_DUM	.00	.00	.00	.00	.00	.00	.00	.00
	CAP_DUM	.00	1.00	.06	.23	.00	1.00	.01	.12
	DUM99	.00	1.00	.19	.39	.00	1.00	.14	.35
	DUM00	.00	1.00	.27	.44	.00	1.00	.15	.36
	DUM01	.00	1.00	.29	.45	.00	1.00	.35	.48
	DUM02	.00	1.00	.25	.43	.00	1.00	.36	.48
222	(n= 3 498)								
	GENDER	.00	1.00	.55	.50	.00	1.00	.55	.50
	AGE	1.00	87.00	40.24	17.31	13.00	82.00	34.23	14.36
	LOS	1.00	29.00	3.57	2.81	1.00	17.00	4.46	2.49
	WAIT_T1	1.00	895.00	229.32	179.39	1.00	681.00	176.50	143.81
	WAIT_GUAR	.00	1.00	.30	.46	.00	1.00	.18	.38
	DIST_NN	.00	533.90	96.40	79.18	.00	530.30	104.92	82.57
	MIG_RATE	.00	.59	.05	.05	.01	.59	.09	.11
	SUB_DIAG	.00	7.00	.43	.72	.00	5.00	.64	.91
	SUR_PRO	1.00	9.00	2.46	1.49	1.00	10.00	3.55	2.11
	PRIV_DUM	.00	.00	.00	.00	.00	.00	.00	.00
	CAP_DUM	.00	1.00	.06	.24	.00	1.00	.04	.20
	DUM99	.00	1.00	.19	.39	.00	1.00	.14	.35

	DUM00	.00	1.00	.22	.41	.00	1.00	.12	.33
	DUM01	.00	1.00	.24	.42	.00	1.00	.31	.46
	DUM02	.00	1.00	.35	.48	.00	1.00	.43	.50
241	(n= 2 994)								
	GENDER	.00	1.00	.33	.47	.00	1.00	.18	.38
	AGE	1.00	92.00	55.25	17.81	17.00	86.00	51.53	12.82
	LOS	1.00	56.00	7.95	6.28	1.00	38.00	5.25	2.74
	WAIT_T1	1.00	1,433.00	191.44	286.34	1.00	677.00	118.77	93.74
	WAIT_GUAR	.00	1.00	.60	.49	.00	1.00	.08	.27
	DIST_NN	.00	517.40	87.08	68.64	.00	505.00	104.59	61.68
	MIG_RATE	.00	.19	.04	.03	.00	.59	.06	.10
	SUB_DIAG	.00	7.00	.92	1.01	.00	4.00	.32	.60
	SUR_PRO	.00	7.00	.21	.61	.00	3.00	.02	.19
	PRIV_DUM	.00	.00	.00	.00	.00	1.00	.00	.06
	CAP_DUM	.00	1.00	.00	.05	.00	1.00	.01	.08
	DUM99	.00	1.00	.18	.38	.00	1.00	.16	.37
	DUM00	.00	1.00	.29	.45	.00	1.00	.23	.42
	DUM01	.00	1.00	.27	.44	.00	1.00	.26	.44
	DUM02	.00	1.00	.26	.44	.00	1.00	.35	.48
243	(n= 3 044)								
	GENDER	.00	1.00	.53	.50	.00	1.00	.52	.50
	AGE	1.00	96.00	50.65	16.33	12.00	85.00	45.18	16.46
	LOS	1.00	37.00	3.62	4.41	1.00	24.00	2.58	3.18
	WAIT_T1	1.00	567.00	115.08	110.69	1.00	367.00	96.15	77.80
	WAIT_GUAR	.00	1.00	.51	.50	.00	1.00	.46	.50
	DIST_NN	.00	530.30	99.92	71.76	.00	530.30	117.20	77.21
	MIG_RATE	.00	.52	.04	.03	.00	.59	.14	.17
	SUB_DIAG	.00	7.00	.46	.92	.00	4.00	.42	.84
	SUR_PRO	.00	4.00	.06	.32	.00	1.00	.02	.13
	PRIV_DUM	.00	.00	.00	.00	.00	.00	.00	.00

	CAP_DUM	.00	1.00	.04	.21	.00	1.00	.04	.20
	DUM99	.00	1.00	.21	.41	.00	1.00	.15	.36
	DUM00	.00	1.00	.27	.44	.00	1.00	.27	.45
	DUM01	.00	1.00	.27	.45	.00	1.00	.27	.45
	DUM02	.00	1.00	.25	.43	.00	1.00	.31	.46
35	(n= 5 340)								
	GENDER	.00	1.00	.69	.46	.00	1.00	.78	.42
	AGE	.00	90.00	42.78	19.30	.00	76.00	45.98	13.53
	LOS	1.00	31.00	1.91	2.34	1.00	19.00	1.32	1.39
	WAIT_T1	1.00	778.00	159.48	167.21	1.00	458.00	85.30	77.38
	WAIT_GUAR	.00	1.00	.31	.46	.00	1.00	.73	.44
	DIST_NN	.00	517.40	73.23	64.28	.00	464.00	84.05	63.63
	MIG_RATE	.00	.30	.04	.04	.00	.59	.07	.08
	SUB_DIAG	.00	7.00	.34	.71	.00	5.00	.06	.34
	SUR_PRO	.00	7.00	.16	.46	.00	4.00	.04	.25
	PRIV_DUM	.00	.00	.00	.00	.00	1.00	.00	.03
	CAP_DUM	.00	1.00	.23	.42	.00	1.00	.08	.26
	DUM99	.00	1.00	.11	.32	.00	1.00	.02	.15
	DUM00	.00	1.00	.23	.42	.00	1.00	.04	.20
	DUM01	.00	1.00	.32	.47	.00	1.00	.35	.48
	DUM02	.00	1.00	.33	.47	.00	1.00	.59	.49

AGE = Age in years;

DIST_NN = Distance from patients home municipality to next nearest hospital supplying DRG in stay;

DUM99 to DUM02 = Hospital stay year dummy variables: actual year:1;

GENDER = Female:0, Male:1;

LOS = Length of stay in days;

MIG_RATE = Fraction inter-regional mobile patients of all elective stays, in home municipality;

CAP_DUM = Capitol Oslo home county of patient:1;

PRIV_DUM = Hospital stay in privately owned hospital:1;

SUB_DIAG = Number of sub-diagnosis registered;

SUR_PRO = Number of surgical procedures performed;

WAIT_GUAR = Waiting list time guarantee:1;

WAIT_T1 =Waiting time from referral to hospital admittance in days;

DRG descriptors. Medical (m) and surgical (s) . Source:

http://norddrg.kuntaliitto.fi/manual_2001/

105 Cardiac valve procedures w/o cardiac cath (s)

107 Coronary bypass w/o cardiac cath (s)

112 Percutaneous cardiovascular procedures (s)

132 Atherosclerosis w cc (m)

133 Atherosclerosis w/o cc (m)

140 Angina pectoris (m)

143 Chest pain (m)

162 Inguinal & femoral hernia procedures, age > 17 w/o cc (s)

209 Major joint & limb reattachment procedures of lower extremity (s)

215 Back & neck procedures w/o cc (s)

222 Knee procedures w/o cc (s)

241 Connective tissue disorders w/o cc (m)

243 Medical back problems (m)

35 Other disorders of nervous system w/o cc (m)